SOME NOTES ON THE INTERNAL ANATOMY OF *LITHOPS:* I

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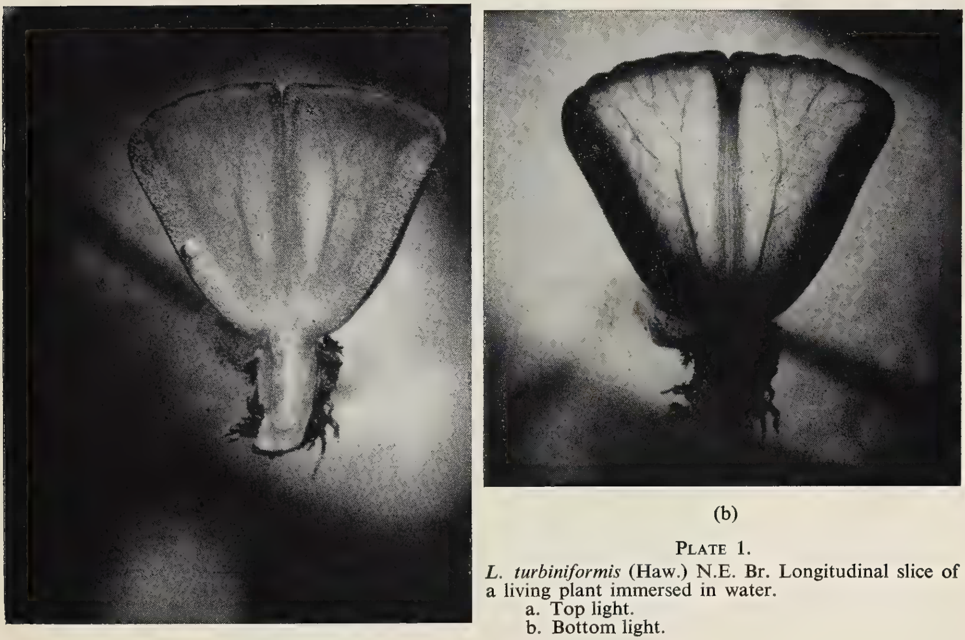
Many studies have been made that were concerned primarily with the taxonomy of the genus *Lithops*, and many workers, both professional botanists and laymen, have contributed to our knowledge of the coloration patterns and the markings on the surfaces of these plants. A search of the literature, however, reveals that very little information has been assembled concerning their internal cellular anatomy. It is the intent of this paper to present some of this anatomical detail.


(a)

(b)

PLATE 1.
L. turbiniformis (Haw.) N.E. Br. Longitudinal slice of a living plant immersed in water.
a. Top light.
b. Bottom light.

Plate 1 shows a longitudinal slice of a 2-year old *Lithops turbiniformis* that was sectioned with a razor blade. It was photographed under water to prevent dessication. A prominent band of chlorenchyma cells can be seen lying beneath the abaxial epidermis and a narrower band is located on either side of the cleft. The central core of each leaf consists mainly of water-storage parenchyma cells and strands of xylem vessels. At the point where the mature leaves are attached to the root-stem complex, the faint beginnings of the growth of a new pair of leaves can be discerned. The arrangement of the vascular bundles is better seen in the bottom-lighted specimen shown in plate 1 (b). The lateral dark bands are the chlorenchyma cells as is also the dark upper central area.

Plate 2 is a photograph of an unidentified *Lithops* that had been preserved, dehydrated, and cleared in xylol. In handling the specimen, the new leaves were accidentally detached from the root-stem complex so that only the old leaves remained. A button of tissue was revealed which appears to be the stem of the plant since the strands of xylem that enter the leaves are arising from it. However, a study of microtomed sections of this region reveals no evidence of cellular

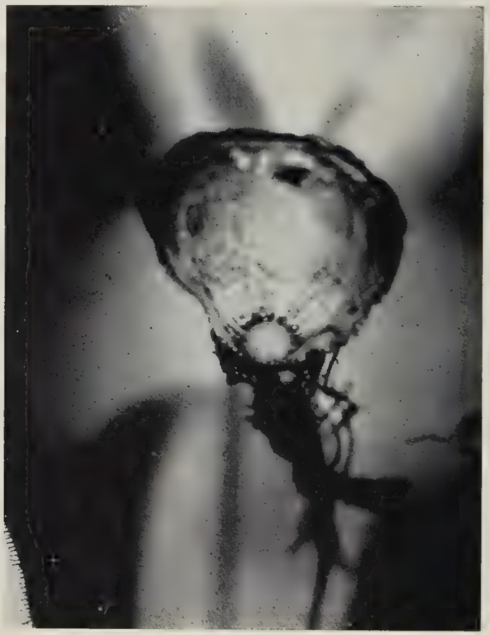


PLATE 2.
Lithops sp. Dissected plant showing button-like remnant of stem.

differentiation into distinct root and stem tissues as they are typically seen in dicotyledonous plants.

Plate 3 shows the results of an experiment concerned with the movement of water from the older leaves of the plant into the newer ones. One of the leaves of a 1-year-old seedling of *L. helmutii*, in soil, was injected via a hypodermic needle with a drop of aniline blue dye. An hour afterward the plant was uprooted, washed free of soil, longitudinally sectioned with a razor blade, and immersed in 1% hydrochloric acid. It will be noted that the dye has travelled down the xylem from the injection site into the root-stem complex, and then ascended into both of the new leaves and the old leaf on the opposite side. Both this plate and plate 1 (b) indicate a dichotomous type of venation in the *Lithops* leaf.

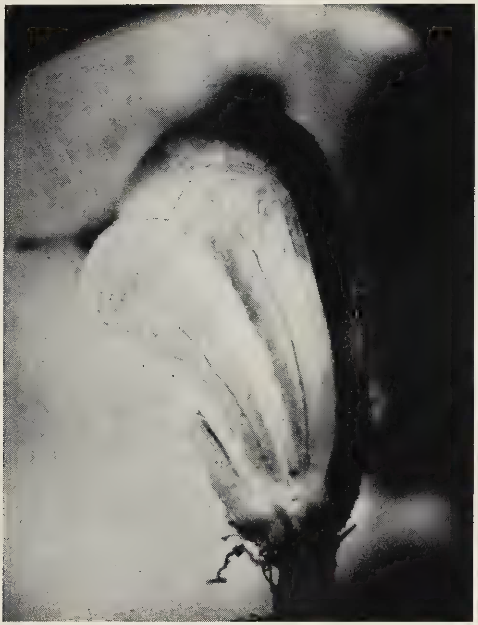


PLATE 3.
L. helmutii L. Bol. Living plant injected with aniline blue and showing dichotomous veining in new leaves.

Plate 4 shows a plant that was similarly injected, but was also preserved, dehydrated, and cleared. Aniline blue followed by 1% HCl was the only stain of several tried that was retained by the plant during the necessary processing; in all other techniques the stains were removed by the alcohol used in the dehydration of the tissue. Although this passage of the dye through the plant does not rigorously prove that cell fluids also pass from the old leaves into the new growth, it does show that a route for such a flow exists.

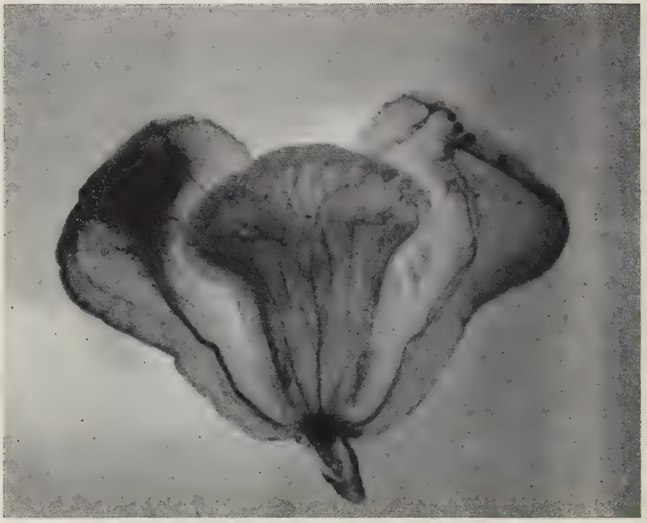


PLATE 4.
Lithops sp. Preserved plant showing injection site in old leaf (upper left) and route of dye as it passed into new leaves and old leaf of opposite side.

When this work was started some two years ago, it was decided that two plants of each species or variety would be cut into ¼-inch slices and preserved. One plant was to be cut transversely and the other longitudinally. As the preservation proceeded, however, the excessive shrinkage of the tissue in the FAA-type preservative made it necessary to devise a formula especially suited to succulent material. A solution consisting of phosphomolybdic acid combined with small amounts of formalin and acetic acid was found to give satisfactory, shrinkage-free, preservation of the gross specimen as well as good cytological detail in the microtomed sections, and it has been used consistently since.

As one proceeds with the dehydration and clearing of many species of *Lithops* his attention is drawn to the reddish-coloured bodies that are to be found scattered among the parenchyma cells just below the epidermis of the

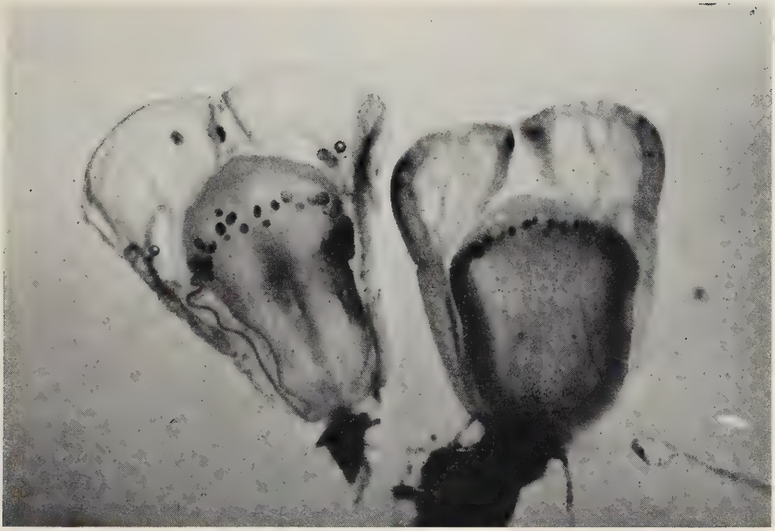
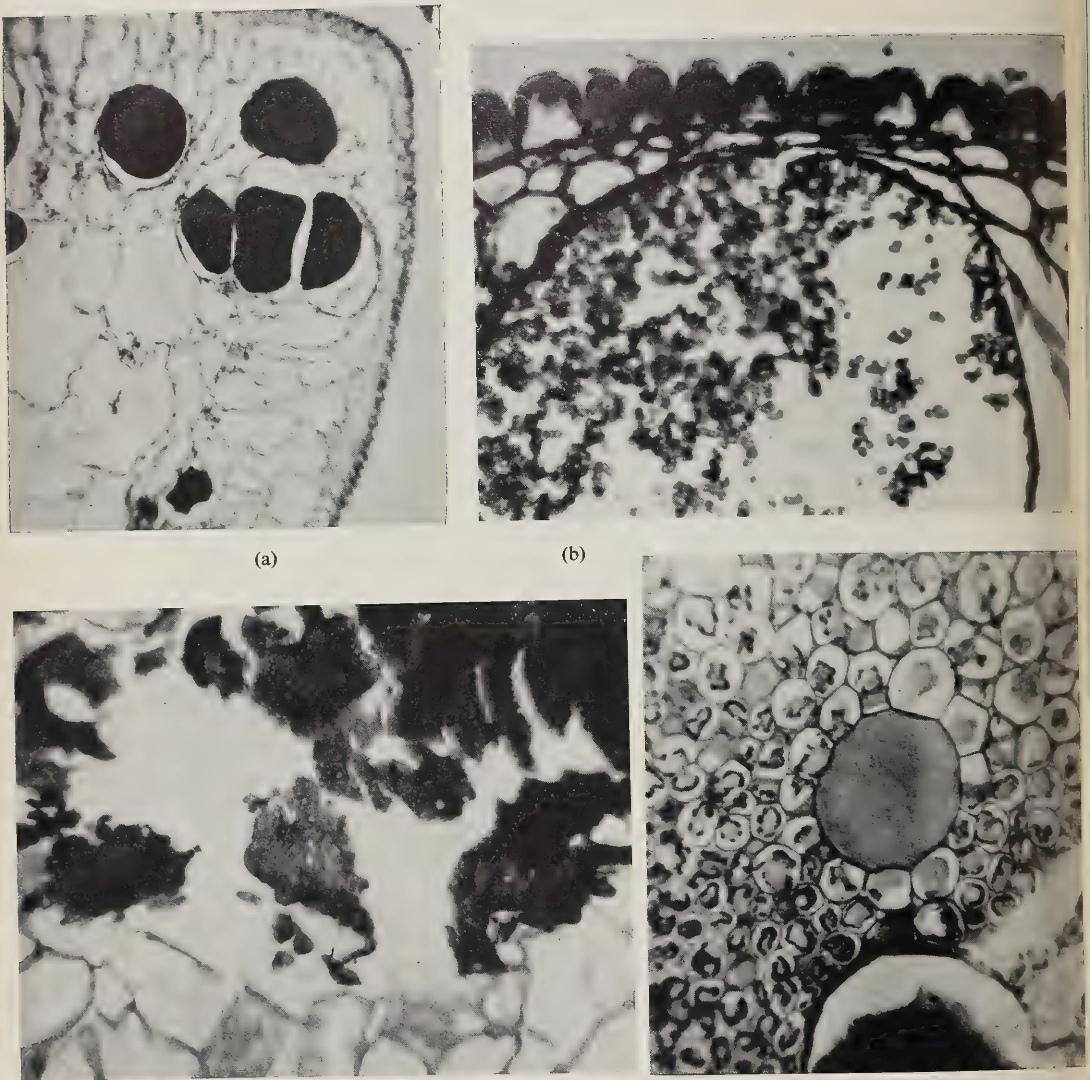


PLATE 5.
L. localis (N.E. Br.) Schw. Tanniniferous idioblasts in new leaves.

top surface. Sometimes these bodies, which are known as tanniniferous idioblasts, are also beneath the ab- and adaxial surfaces. See plate 4 upper right side, and plate 5 where idioblasts appear to be limited to new leaves only. These bodies are normally invisible in the fresh *Lithops* leaf because there they are colourless. However, the same colour that develops during dehydration of the plant in alcohol may also develop during the natural dehydration of old shrivelling leaves, and then the idioblasts can be seen as one peers through the epidermis. They are also always readily apparent in the dried-up epidermal covering found on *L. lesliei* just before the new leaves break through. Similar tannin-containing sacs are common to those other *Mesembryanthema* that I have checked. On the other hand, certain specific *Lithops* plants that I have processed have failed to show any idioblasts, so the possibility exists that these bodies may come and go in response to some unidentified metabolic cycle.

The study of the tanniniferous idioblasts is interesting from at least two points of view. Examination of sectioned material with the microscope reveals at least four distinct types of idioblast construction. See plate 6. Type a. appears to be quite glass-like. It is so hard that it usually fragments under the impact of the microtome knife, but the fragments have no discernible in-



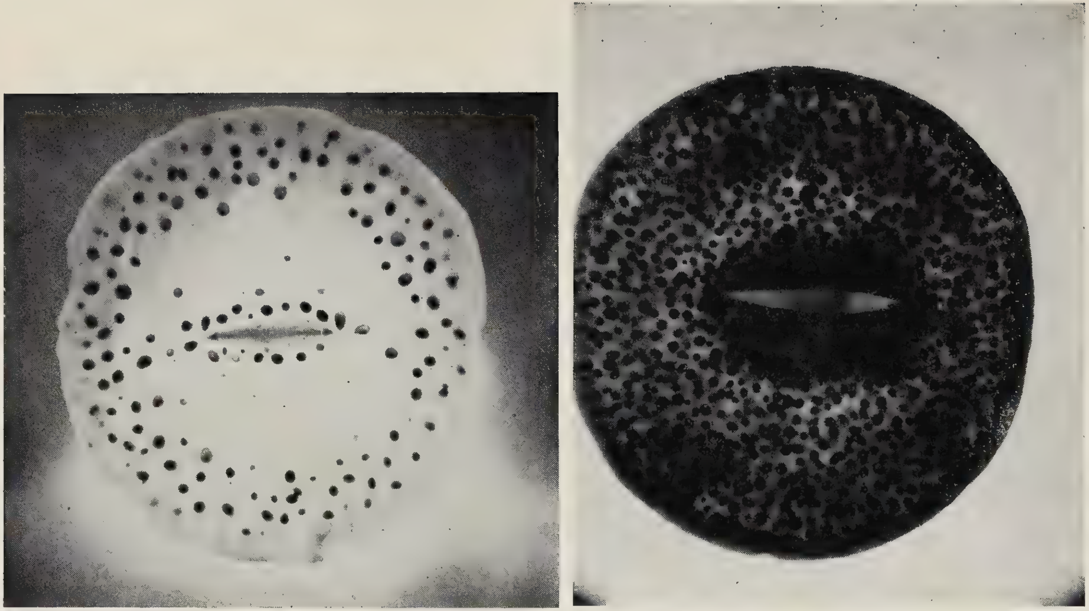
(a) (b)

(c) (d)

Plate 6.

Tanniniferous idioblasts.

a. *L. aucampiae* L. Bol. Amorphous-type idioblasts (× 100).
b. *L. glaudinae* de Boer Plastid-type idioblast (× 430).
c. *L. ruschiorum* (Dint. & Schw.) N.E. Br. Vacuolated-type idioblast (× 430).
d. *L. verruculosa* var. *inae* (Nel) de Boer & Boom Finegrain-type idioblast (× 100).



(a) (b)

Plate 7.
Spatial relationships of tanniniferous idioblasts.
a. *L. aucampiae* L. Bol.
b. *L. lesliei* (N.E. Br.) N.E. Br.

ternal structure. Type b. is composed of small plastid-like bodies that are attached to each other in irregular groupings. Also this type of idioblast very often shows a denser, nucleus-like region as may be seen in plate 5. Type c. resembles type a. except that the glassy mass is vacuolated like styrifoam or the gas bubbles in lava rock. Type d. has a very fine-grained texture. To what extent these four types may have any species specificity or, indeed, to what extent they may be artifacts of dehydration is difficult to ascertain, since they cannot be dissected out of the fresh leaf for comparison. However, in sectioned material I have found up to three of the four types in one plant at one time. Further investigation will have to be made to determine to what extent the types of idioblasts are real and constant and hence of some possible taxonomic significance.

The second aspect of these bodies that arouses interest concerns their size, number, and placement within the plant. If the upper $\frac{1}{4}$-inch of a young *L. aucampiae* is removed from the plant and is preserved, dehydrated, and cleared, it takes on the appearance seen in plate 7 (a), and this appearance is constant for all *L. aucampiae* of similar age and cultural conditions that I have treated. Likewise, *L. lesliei*, seen in plate 7 (b), has a configuration of idioblasts that is distinctive and constant also. Hence, in this regard it may likewise be true that a study of large numbers of specimens from all the species and varieties, and raised under differing cultural conditions, may produce information of taxonomic significance.

ACKNOWLEDGEMENTS

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REFERENCES

METCALFE, C. R. and Chalk, L. (1950): *Anatomy of the Dicotyledons.* **1.** Oxford Universit
Press, London.